REMARKS:

Claims 27-52 are pending in the application. Claims 1, 14 and 19-26 were rejected under 35 U.S.C. § 112, second paragraph as described in paragraphs 4-7 of the Office Action. Claim 1 was rejected under 35 U.S.C. § 103 as described in paragraph 9 of the Office Action. Claims 2-18 have been rejected under 35 U.S.C. § 103 as described in paragraphs 9-11 of the Office Action. Claims 19-26 were indicated as being allowable if rewritten to overcome the rejections under 35 U.S.C. § 112, second paragraph and to include all the limitations of the base claim and any intervening claims.

Claims 27, 45, 51 and 52 are the only independent claims.

The specification has been amended to place the application in correct idiomatic English. Attached hereto is a marked-up version of the changes made to the specification by the current amendment. The attachment is captioned "**Version with Markings to Show Changes Made**."

It is respectfully submitted that the outstanding rejections are moot, as claims 1-26 have been cancelled.

It is respectfully submitted that newly added claims 27-52 have been drafted to conform with 35 U.S.C. § 112, second paragraph.

It is respectfully submitted that "movable electrode" is definite within the meaning of 35 U.S.C. § 112, second paragraph. In paragraph 4 of the Office Action, the Examiner asserts that "movability" is not clearly understood because "the specific method as to cause the movement is not well defined." The Examiner then states that moving "can be done in one of several ways." However, it is respectfully submitted that breadth of a claim is not to be equated with indefiniteness. *In re Miller* 169 USPQ 597 (CCPA 1971). It is respectfully submitted that the scope of the subject matter embraced by the claims is clear. Furthermore, it is respectfully submitted that Applicants have not otherwise indicated that they intend the invention to be of a scope different from that defined in the claims. Accordingly, in light of MPEP § 2173.04, it is respectfully submitted that the Examiner's basis for rejecting claims 1 and 19-26 under 35 U.S.C. § 112, second paragraph is improper. Therefore, it is respectfully submitted that newly added claims 27 and 45-52 are definite within the meaning of 35 U.S.C. § 112, second paragraph.

(14 Prev.)

With respect to paragraph 5 of the Office Action, it is respectfully submitted that claim 40 is definite within the meaning of 35 U.S.C. § 112, second paragraph for the following reason. Newly added claim 40 has been drafted in order to clearly indicate that a transparent adhesive layer or a transparent re-peel sheet adhesively bonds one of a stationary electrode portion-directly-formed member and a liquid crystal display or the stationary electrode portion-directly-formed member, the liquid crystal display and a member disposed therebetween.

It is respectfully submitted that the terms "movable-side sheet" and "movable electrode" are definite within the meaning of 35 U.S.C. § 112, second paragraph. A fundamental principle contained in 35 U.S.C. § 112, second paragraph is that the Applicants are their own lexicographers. MPEP §2173.01. It is respectfully submitted that "movable-side" and "movable electrode" are not used in ways that are contrary to accepted meanings in the art. For this reason it is respectfully submitted that the rejections of claims 19-26 under 35 U.S.C. § 112, second paragraph as described in paragraph 7 of the Office Action is improper. Furthermore, it is respectfully submitted that claims 45-52 are definite within the meaning of 35 U.S.C. § 112, second paragraph.

It is respectfully submitted that the rejections discussed on paragraph 9, page 4 and paragraphs 9-22, pages 5-6 of the Office Action are not clear. Specifically, paragraph 9 on page 4 of the Office Action discusses a rejection of claim 1 under 35 U.S.C. § 103 over Minoura in view of Fuzimori. More particularly, paragraph 9 on page 4 of the Office Action indicates that Fuzimori "does not explicitly disclose the specific orientation" of the two polarizers and the optical phase difference films. Accordingly, the Examiner relies on a teaching of Minoura in an attempt to establish a *prima facie* case of obviousness of claim 1.

However, in paragraph 9 [sic] on page 5 of the Office Action, claims 5-18, which are dependent upon claim 1, are rejected under 35 U.S.C. § 103 over Shinohara in view of Fuzimori. In this paragraph of the Office Action, the Examiner indicates that Fuzimori "does not explicitly disclose the formation" of phase difference plates. Accordingly, the Examiner relies on a teaching of Shinohara to establish a *prima facie* case of obviousness via a teaching of "thermoplastic resin film for a phase retardation film with a temperature of stretching of 170degrees" and a thickness of 100 microns. Shinohara is also relied upon for a teaching of "formation of transparent electrodes on the

films that are bonded and/or laminated to the liquid crystal." Finally, Shinohara is relied upon for a teaching of a "moisture resistence film as a protective film laminated either one or both sides of the polarizers."

However, the Examiner fails to address the limitations in claim 1, which are thereby inherently included in claims 15-18, that presumably were taught in the disclosure of Minoura as described in paragraph 9 on page 4 of the Office Action. For this reason it is respectfully submitted that a combination of Shinohara in view of Fuzimori does not teach that which is claimed in claims 5-18. On the contrary, in light of the discussion in paragraph 9 on page 4 of the Office Action, at the very least, a combination of Minoura in view of Fuzimori, and in further view of Shinohara might possibly teach that which is required in claims 5-18. However, it is respectfully submitted that the Examiner has failed to establish even such a *prima facie* case of obviousness.

With respect to paragraph 10 of the Office Action, it is unclear as to what prior art claims 2-4 were rejected. Specifically, it is not clear whether claims 2-4 were rejected over the combination of Minoura in view of Fuzimori as described in paragraph 9 on page 4 of the Office Action or if claims 2-4 were rejected under the combination of Shinohara in view of Fuzimori as described in paragraph 9 on page 5 of the Office Action.

In light of the above discussion, Applicants presume that the intent of the Examiner was to reject each of claims 1-26 over at least a combination of Minoura in view of Fuzimori. Specifically, it seems that claims 1 and 2-4 were intended to be rejected under a combination of Minoura in view of Fuzimori whereas claims 5-18 were intended to be rejected over a combination of Minoura in view of Fuzimori and in further view of Shinohara.

Attached hereto is an English translation of the priority documents JP 10-14850 and JP 10-215198 accompanied with a statement verifying the accuracy of the translations. Further it is respectfully submitted that the subject matter in claims 27-52 is fully supported by the '850 and '198 documents. As such, it is respectfully submitted that Minoura is not prior art within the meaning of 35 U.S.C. § 102. Accordingly, it is respectfully submitted that claims 27-52 are patentable over the combination of the remaining applied prior art.

Having fully and completely responded to the Office Action, Applicants submit that all of the claims are now in condition for allowance, an indication of which is respectfully solicited.

If there are any outstanding issues that might be resolved by an interview or an Examiner's amendment, the Examiner is requested to call Applicants' attorney at the telephone number shown below.

Respectfully submitted,

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higher refractive index, the larger the difference between those refractive indices is, the more the reflection of light occurs at the interface.

In the case of the constitution in which the upper polarizer 8 is disposed on the upper surface of the movable-side sheet 20 of the transparent touch panel 1, indeed a method of preventing reflected light by forming the upper surface of the upper polarizer 8 into a satin finish state is also available, but reflected light cannot be suppressed enough.

Accordingly, an object of the present invention is to provide a liquid crystal display device of a touch input type, as well as its fabricating method, which is low in reflection, high in contrast, and high in visibility even in such places as indoors with fluorescent lamps or the like and outdoors, by solving the above-described issues.

Disclosure Of Invention

In order to achieve the above object, the present invention has the following constitutions.

According to a first aspect of the present invention, there is provided a touch-input type liquid crystal display device having a liquid crystal display below a touch panel, in which an upper polarizer is disposed on an upper surface of a transparent touch panel in which an upper optical phase difference film and a lower optical phase

difference film are disposed with a space layer interposed therebetween. The upper optical phase difference film ~~serving~~ serves to give a phase delay of a 1/4 wavelength to incident light of a center wavelength within a visible region and ~~having~~ has a movable electrode portion on a lower surface thereof. ~~and~~ The lower optical phase difference film ~~serving~~ serves to give a phase delay of a 1/4 wavelength to the incident light of the center wavelength within the visible region and ~~having~~ has a stationary electrode portion on an upper surface thereof. ~~and~~

A lower polarizer is disposed on a lower surface of the liquid crystal display.

~~wherein~~ An angle formed by an optical axis of the upper optical phase difference film and a polarization axis of the upper polarizer is about 45°. An angle formed by an optical axis of the lower optical phase difference film and linearly polarized light that is to be outputted from a device surface out of linear polarization emitted from the liquid crystal display is about 45°. An angle formed by the optical axis of the upper optical phase difference film and the optical axis of the lower optical phase difference film is about 90°. ~~and wherein~~ An angle formed by the polarization axis of the upper polarizer and linearly polarized light that is to be outputted from the device surface out of linearly polarized light emitted from the liquid crystal

display is 90°.

According to a second aspect of the present invention, there is provided a touch-input type liquid crystal display device according to the first aspect, wherein the stationary electrode portion is formed directly on the lower optical phase difference film.

According to a third aspect of the present invention, there is provided a touch-input type liquid crystal display device according to the first aspect, wherein a glass substrate having optical isotropy is disposed between the stationary electrode portion and the lower optical phase difference film. ~~and~~ The stationary electrode portion in the third aspect is formed directly on the glass substrate having optical isotropy.

According to a fourth aspect of the present invention, there is provided a touch-input type liquid crystal display device according to the first aspect, wherein an optically isotropic film is disposed between the stationary electrode portion and the lower optical phase difference film. ~~and~~ The stationary electrode portion in the fourth aspect is formed directly on the optically isotropic film.

According to a fifth aspect of the present invention, there is provided a touch-input type liquid crystal display device according to the second aspect, wherein both the upper optical phase difference film and the

invention, there is provided a touch-input type liquid crystal display device according to the fourth aspect, wherein both the upper optical phase difference film and the optically isotropic film have a thermal deformation temperature of not less than 170°C.

According to an 11th aspect of the present invention, there is provided a touch-input type liquid crystal display device according to any one of the first to 10th aspects, wherein a transparent resin plate having optical isotropy is disposed between the transparent touch panel and the liquid crystal display.

According to a 12th aspect of the present invention, there is provided a touch-input type liquid crystal display device according to the fourth, ninth, or 10th aspect, wherein a transparent resin plate having optical isotropy is disposed between the optically isotropic film and the lower optical phase difference film.

According to a 13th aspect of the present invention, there is provided a touch-input type liquid crystal display device according to any one of the first to 12th aspects, wherein a thickness of the upper optical phase difference film is not less than 50 μm and not more than 150 μm.

According to a 14th aspect of the present invention, there is provided a touch-input type liquid

crystal display device according to any one of the first to 13th aspects, wherein either one of a member on which the stationary electrode portion has been directly formed and the liquid crystal display~~s~~. ~~and~~ Further in accordance with the 14th aspect of the present invention, all of the stationary electrode portion-directly-formed member and the liquid crystal display and a member disposed between the stationary electrode portion-directly-formed member and the liquid crystal display are adhesively bonded overall by a transparent adhesive layer or a transparent re-peel sheet.

According to a 15th aspect of the present invention, there is provided a touch-input type liquid crystal display device according to any one of the first to 14th aspects, wherein a transparent film low in moisture permeability and superior in dimensional stability is laminated on an upper surface of the upper polarizer.

According to a 16th aspect of the present invention, there is provided a touch-input type liquid crystal display device according to the 15th aspect, further comprising a low-reflection processed layer on an upper surface of the transparent film laminated on the upper surface of the upper polarizer.

According to a 17th aspect of the present invention, there is provided a touch-input type liquid crystal display device according to the 15th aspect, further comprising an antifouling processed layer on an upper

surface of the transparent film laminated on the upper surface of the upper polarizer.

According to an 18th aspect of the present invention, there is provided a touch-input type liquid crystal display device according to the 15th aspect, further comprising a hard coat processed layer on an upper surface of the transparent film laminated on the upper surface of the upper polarizer.

According to a 19th aspect of the present invention, there is provided a method for fabricating a touch-input type liquid crystal display device having a liquid crystal display below a touch panel, wherein in the liquid crystal display device, an upper polarizer is disposed on an upper surface of a transparent touch panel in which an upper optical phase difference film and a lower optical phase difference film are disposed with a space layer interposed therebetween, the upper optical phase difference film serving to give a phase delay of a 1/4 wavelength to incident light of a center wavelength within a visible region and having a movable electrode portion on a lower surface thereof, and the lower optical phase difference film serving to give a phase delay of a 1/4 wavelength to the incident light of the center wavelength within the visible region and having a stationary electrode portion on an upper surface thereof; and a lower polarizer

is disposed on a lower surface of the liquid crystal display; wherein an angle formed by an optical axis of the upper optical phase difference film and a polarization axis of the upper polarizer is about 45°, an angle formed by an optical axis of the lower optical phase difference film and linearly polarized light that is to be outputted from a device surface out of linear polarization emitted from the liquid crystal display is about 45°, an angle formed by the optical axis of the upper optical phase difference film and the optical axis of the lower optical phase difference film is about 90°, and wherein an angle formed by the a polarization axis of the upper polarizer and linearly polarized light that is to be outputted from the device surface out of linearly polarized light emitted from the liquid crystal display is 90°;.

The method in accordance with the 10th aspect of the present invention comprises ~~comprising:~~ obtaining a movable-side sheet by, after performing a heat treatment for removal of residual solvents in film material of the upper optical phase difference film, forming a transparent electrically conductive film for the movable electrode portion directly on the film material;. ~~and~~ After performing a heat treatment for reducing dimensional errors involved in formation of leads, The method includes forming leads of the movable electrode portion, and further performing a heat treatment for curing of binder of

ink with which the leads have been formed, as well as for removal of solvents of the ink.

The method in accordance with the 19th aspect further includes obtaining a stationary-side sheet by, after performing a heat treatment for removal of residual solvents in film material of the lower optical phase difference film, forming a transparent electrically conductive film for the stationary electrode portion directly on the film material, and after performing a heat treatment for reducing dimensional errors involved in formation of leads, forming leads of the stationary electrode portion, and further performing a heat treatment for curing of binder of ink with which the leads have been formed, as well as for removal of solvents of the ink.

The method in accordance with the 19th aspect still further includes laminating together the movable-side sheet and the stationary-side sheet,

then laminating the upper polarizer on an upper surface of the upper optical phase difference film of the movable-side sheet and thereafter performing a pressure degassing process. ~~and~~ The method finally includes

laminating together the stationary-side sheet with the liquid crystal display.

According to a 20th aspect of the present invention, there is provided a method for fabricating a touch-input type liquid crystal display device having a liquid crystal display below a touch panel, wherein in the

liquid crystal display device, an upper polarizer is disposed on an upper surface of a transparent touch panel in which an upper optical phase difference film and a lower optical phase difference film are disposed with a space layer interposed therebetween, the upper optical phase difference film serving to give a phase delay of a 1/4 wavelength to incident light of a center wavelength within a visible region and having a movable electrode portion on a lower surface thereof, and the lower optical phase difference film serving to give a phase delay of a 1/4 wavelength to the incident light of the center wavelength within the visible region and having a stationary electrode portion on an upper surface thereof; and a lower polarizer is disposed on a lower surface of the liquid crystal display, wherein an angle formed by an optical axis of the upper optical phase difference film and a polarization axis of the upper polarizer is about 45°, an angle formed by an optical axis of the lower optical phase difference film and linearly polarized light that is to be outputted from a device surface out of linear polarization emitted from the liquid crystal display is about 45°, an angle formed by the optical axis of the upper optical phase difference film and the optical axis of the lower optical phase difference film is about 90°, and wherein an angle formed by the polarization axis of the upper polarizer and linearly polarized light

that is to be outputted from the device surface out of linearly polarized light emitted from the liquid crystal display is 90°~~;~~.

The method ~~comprising~~ in accordance with the 20th aspect of the present invention comprises:

obtaining a movable-side sheet by, after performing a heat treatment for removal of residual solvents in film material of the upper optical phase difference film, forming a transparent electrically conductive film for the movable electrode portion directly on the film material, and after performing a heat treatment for reducing dimensional errors involved in formation of leads, forming leads of the movable electrode portion, and further performing a heat treatment for curing of binder of ink with which the leads have been formed, as well as for removal of solvents of the ink~~;~~.

The method in accordance with the 20th aspect of the present invention additionally comprises obtaining a stationary-side sheet by forming a transparent electrically conductive film for the stationary electrode portion directly on a glass substrate having optical isotropy, forming leads of the stationary electrode portion, and performing a heat treatment for curing of binder of ink with which the leads have been formed, as well as for removal of solvents of the ink~~;~~.

The method in accordance with the 20th aspect of the present invention further comprises laminating together the movable-side sheet and the stationary-side sheet~~;~~, and then, laminating the upper polarizer on an upper

surface of the upper optical phase difference film of the movable-side sheet and thereafter performing a pressure degassing process. ~~and~~

The method in accordance with the 20th aspect of the present invention finally includes laminating together the stationary-side sheet with the liquid crystal display with the lower optical phase difference film interposed therebetween.

According to a 21st aspect of the present invention, there is provided a method for fabricating a touch-input type liquid crystal display device having a liquid crystal display below a touch panel, wherein in the liquid crystal display device, an upper polarizer is disposed on an upper surface of a transparent touch panel in which an upper optical phase difference film and a lower optical phase difference film are disposed with a space layer interposed therebetween, the upper optical phase difference film serving to give a phase delay of a 1/4 wavelength to incident light of a center wavelength within a visible region and having a movable electrode portion on a lower surface thereof, and the lower optical phase difference film serving to give a phase delay of a 1/4 wavelength to the incident light of the center wavelength within the visible region and having a stationary electrode portion on an upper surface thereof; and a lower polarizer is disposed on a lower surface of the liquid crystal display, wherein an angle formed by an optical axis of the upper

optical phase difference film and a polarization axis of the upper polarizer is about 45°, an angle formed by an optical axis of the lower optical phase difference film and linearly polarized light that is to be outputted from a device surface out of linear polarization emitted from the liquid crystal display is about 45°, an angle formed by the optical axis of the upper optical phase difference film and the optical axis of the lower optical phase difference film is about 90°, and wherein an angle formed by the a polarization axis of the upper polarizer and linearly polarized light that is to be outputted from the device surface out of linearly polarized light emitted from the liquid crystal display is 90°.

The method ~~comprising:~~ in accordance with the 21st aspect of the present invention comprisis obtaining a movable-side sheet by, after performing a heat treatment for removal of residual solvents in film material of the upper optical phase difference film, forming a transparent electrically conductive film for the movable electrode portion directly on the film material, and after performing a heat treatment for reducing dimensional errors involved in formation of leads, forming leads of the movable electrode portion, and further performing a heat treatment for curing of binder of ink with which the leads have been formed, as well as for removal of solvents of the ink.

The method in accordance with the 21st aspect of the present invention further comprises obtaining a stationary-side sheet by, after performing a heat treatment for removal of residual solvents in film material of an optically isotropic film, forming a transparent electrically conductive film for the stationary electrode portion directly on the film material, and after performing a heat treatment for reducing dimensional errors involved in formation of leads, forming leads of the stationary electrode portion, and further performing a heat treatment for curing of binder of ink with which the leads have been formed, as well as for removal of solvents of the ink;

The method in accordance with the 21st aspect of the present invention still further comprises laminating together the movable-side sheet and the stationary-side sheet;

laminating the upper polarizer on an upper surface of the upper optical phase difference film of the movable-side sheet and thereafter performing a pressure degassing process; and

laminating together the stationary-side sheet with the liquid crystal display with the lower optical phase difference film interposed therebetween.

According to a 22nd aspect of the present invention, there is provided a method for fabricating a touch-input type liquid crystal display device according to any one of the 19th to 21st aspects, wherein the heat treatment for removal of the residual solvents in the film

touch-input type liquid crystal display device according to any one of the 19th to 25th aspects, wherein electrode-routed portions are preparatorily provided in either one of the movable electrode portion and the stationary electrode portion, and after laminating together the movable-side sheet and the stationary-side sheet, and pressed against and adhered to a connector via an anisotropic conductive adhesive at a temperature of not less than 120°C and less than 170°C.

The touch-input type liquid crystal display device according to the present invention, having the above-described constitutions and functions, produces the following advantages.

That is, by the arrangement that the angle formed by the polarization axis of the upper polarizer and the optical axis of the upper optical phase difference film is set to about 45°, light enters the space layer of the transparent touch panel in the form of circularly polarized light or generally circularly polarized light, and reflected circularly polarized light or generally circularly polarized light passes through the upper optical phase difference film again, resulting in linearly polarized light vertical to the transmission axis of the upper polarizer, so that reflected light is suppressed. The term, polarization axis (or absorption axis) of the upper polarizer ~~8~~, refers to an axis

parallel to the drawing direction of the film material. Light passing through the upper polarizer 8 is polarized, going out from the upper polarizer 8 as linearly polarized light only in a direction perpendicular to the absorption axis. It is noted that an axis perpendicular to the absorption axis is referred to as a transmission axis. In order to allow the linearly polarized light to be transmitted through this upper polarizer 8, the transmission axis and the direction of the linearly polarized light must be coincident with each other. Linearly polarized light out of coincidence is inhibited from being transmitted by the upper polarizer 8.

Also, by setting the lower optical phase difference film between the transparent touch panel and the liquid crystal display in such a manner that the optical axis of the lower optical phase difference film forms an angle of about 90° to the optical axis of the upper optical phase difference film and moreover forms an angle of about 45° to linearly polarized light that should be outputted from the device surface out of the linearly polarized light emitted from the liquid crystal display, coloring of the display screen, as viewed from the observer side, can be suppressed, by which a display screen which is high in contrast and free from coloring can be obtained. It is noted that linearly polarized light that should be outputted

from the device surface, out of the linearly polarized light emitted from the liquid crystal display with a voltage equal to or lower than the threshold voltage, has such a relationship as to form an angle of 90° to the polarization axis of the upper polarizer.

Further, in the touch-input type liquid crystal display device, by applying a lower reflection process to the uppermost surface of the device, reflection of light at the uppermost surface is suppressed.

As a result of these improvements, the liquid crystal display equipped with the transparent touch panel according to the present invention can offer a display screen which less reflects in a room with fluorescent lamps or the like or in outdoor places, is high in contrast, and has very good ~~an~~ visibility.

The present invention, by virtue of its constitutions and functions as described above, can provide a touch-input type liquid crystal display device which is high in contrast and high in visibility by virtue of its capability of suppressing reflected light of fluorescent lamps or the like indoors, and reflected light due to external light outdoors by means of the upper polarizer and the individual layers behind the upper polarizer.

Further, in the case where a transparent film is laminated on the upper surface of the upper polarizer, the

noted here that the description of "about 550 nm center wavelength of the visible region" is only that the center wavelength of the visible region is assumed to be about 550 nm as an example. The reason of the setting to about 550 nm is on the following basis. That is, considering the center wavelength of the visible region in terms of the relation to the human luminosity curve, the human visible region ranges from about 400 nm to 700 nm, a peak of luminosity factor (visual sensitivity) exists at about 550 nm. Therefore, suppressing light reflection at wavelengths of this about 550 nm can make reflection insensible to the human eyes.

The upper optical phase difference film 4 fulfills also a function as a pen or finger input of the touch panel, and so needs to have flexibility for easier input operation.

Also, because the upper optical phase difference film 4 is high-temperature-treated during the formation of the movable electrode portion 3 and the circuit formation, the film material used is required to have a thermal resistance of 150°C or more. In the case of film materials having lower thermal deformation temperatures (i.e., less than 150°C as will be described later), the retardation value, which is a value of phase delay between the two components of polarized light, would be changed by high

temperature treatment, in which case the visibility of the display screen would be inferior with the constitution of the touch-input type liquid crystal display device according to this embodiment of the present invention. However, it has been found that the higher the thermal deformation temperature (i.e., 150°C or more as will be described later) of the film material is, the smaller the change of the retardation value in high temperature treatment becomes practically negligibly. Such a material is exemplified by uniaxial oriented polymeric films having a thermal deformation temperature of 150°C or more, e.g., polyarylate, polyethersulfone, norbornene base resins, polysulfone, and the like. Particularly, uniaxial oriented polyarylate, polyethersulfone, or polysulfone films having a thermal deformation temperature of 170°C or more are preferable as the film material.

The reason because a film material having a 150°C or more thermal deformation temperature is used as the film material for the upper optical phase difference film 4, as well as the reason because the film material preferably has a 170°C or more thermal deformation temperature, as shown above, are described below in detail.

~~First,~~ the reason ~~because~~ a film material having a 150°C or more thermal deformation temperature is used as the film material for the upper optical phase difference

film 4 is described below.

Generally, when heat equal to or higher than the thermal deformation temperature of the film material of the upper optical phase difference film 4 is applied to the film material of the upper optical phase difference film 4, the film material of the upper optical phase difference film 4 shows such deterioration as deformation or distortion due to the heat. In such a case, it becomes hard for the upper optical phase difference film 4 to retain the 1/4 wavelength phase difference (retardation), thus no longer possible to suppress the reflection or obtain a correct image. Therefore, by the temperatures of later-described heat treatments to be performed on the upper optical phase difference film 4 in this embodiment, usable film materials are limited.

In addition, with a low thermal deformation temperature (e.g., less than 150°C) of the film material of the upper optical phase difference film 4, performing the heat treatment at temperatures less than the low thermal deformation temperature would also inhibit occurrence of deformation or deterioration of the film material of the upper optical phase difference film 4 due to the heat. In such a case, however, the heat treatment would be useless as a matter of course, that is, various effects of the heat treatment as will be described later could no longer be

elliptically polarized light.

Thereafter, the circularly polarized light that has been returned by reflection passes again through the upper optical phase difference film 4, being outputted as linearly polarized light from the upper surface of the upper optical phase difference film 4, while the elliptically polarized light that has been returned by reflection is outputted as elliptically polarized light close to linearly polarized light from the upper surface of the upper optical phase difference film 4. Complete linearly polarized light then perpendicularly crosses the transmission axis (like a slit) of the upper polarizer 8, not being outputted from the upper surface of the upper polarizer 8, so that reflected light can be suppressed. Incomplete linearly polarized light, on the other hand, can block the component perpendicular to the transmission axis of the upper polarizer 8 from being outputted, but allows the component coincident with the transmission axis of the upper polarizer 8 to be outputted from the upper surface of the upper polarizer 8. That is, excess reflection remains.

Even if the polarization axis of the upper polarizer 8 is not accurately at the angle of 45° with respect to the optical axis of the upper optical phase difference film 4, but only if the difference is within ±3°, then the result is almost the same as with the circularly

polarized light (i.e., generally circularly polarized light) and the reflected light outputted from the upper surface of the upper polarizer 8 (top surface of the liquid crystal display device) can be neglected finally.

Next, the material of the upper polarizer 8 is generally a flexible, 200 μm thick polarizer which is obtained by impregnating polyvinyl alcohol with a dichroic pigment such as iodine or dye, and drawing it, and then covering the front and rear surfaces with a cellulose base protector film such as triacetylcellulose. Such an upper polarizer 8 is exemplified by "HEG1425DU made by Nitto Denko Kabushiki Kaisha".

Also, a low-reflection processed layer may be formed on the upper surface of the upper polarizer 8 by applying a low reflection process thereto. The low reflection process may be done by applying a low-reflection material using a low-refractive-index resin such as fluororesin or silicon resin, or forming a metallic multilayer film or laminating a low-reflection film. It is noted here that out of the total reflection of a touch-input type liquid crystal display device, reflection by the touch panel surface accounts for about 4%, and that the process for suppressing this reflection to less than 1% is called the low reflection process.

In order to protect the upper polarizer 8 and the

upper optical phase difference film 4 from wearing due to press by finger or pen, a hard coat processed layer comprising acrylic resin, silicon resin, UV curing resin, or the like may also be deposited on the upper polarizer 8.

By arranging the transparent touch panel 1 and the upper polarizer 8 in such a constitution as shown above, reflected light due to the externally ~~light~~ incident Light ~~from external~~ can be suppressed in the following manner.

Incident light from the observer side passes through the upper polarizer 8, becoming linearly polarized light. When this linearly polarized light passes through the upper optical phase difference film 4 that gives a 1/4 wavelength phase delay to the center-wavelength incident light whose optical axis is inclined by about 45° to the polarization axis of the upper polarizer 8, the linearly polarized light is divided into two polarized components perpendicular to each other and equal in amplitude to each other, one polarized component being given a 1/4 wavelength phase delay. As a result, the linearly polarized light is changed into circularly polarized light or generally circularly polarized light. Then, the circularly polarized light or generally circularly polarized light reflected by an interface between the space layer 7 and the stationary electrode portion 5, which is the largest refractive index portion of the interface, passes again through the upper

sheet is larger than air, close to the refractive indices of such members as the lower optical phase difference film 6, the glass substrate 11 having optical isotropy, the optically isotropic film 12, the transparent resin plate 16 having optical isotropy, the glass plate forming the liquid crystal display 2, and the like, the reflection of light at the interfaces between the transparent adhesive layer or the transparent re-peel sheet and these members is suppressed, so that the transmittance finally becomes higher than that of a constitution having an air space in the case where double-sided tape is used. Besides, because the refractive index of the transparent adhesive layer or the transparent re-peel sheet is close to the refractive indices of the above-mentioned members, refraction of light at the interface between the transparent adhesive layer or the transparent re-peel sheet and the members is suppressed, so that no shadows are formed in the screen display.

Also, the members bonded to each other by the transparent re-peel sheet are characterized by being highly resistant to a vertically-acting pull-away force and a horizontally-displacing force, and easily being separated away from each other when pulled away from both sides in such a manner that the members are peeled off from their ends. Accordingly, there is no ~~afraid~~ expectation of peels ~~in normal~~ during use ~~state~~ of the members after the mounting, so that the

members can easily be peeled off for maintenance or other occasions. In addition, it is needless to say that the adhesive power of the transparent re-peel sheet does not lower even ~~by~~ after repeated removals. Also, in the case where an urethane base polymeric adhesive is used, because the transparent re-peel sheet is a material having both water absorbing and gas sucking properties, the transparent re-peel sheet, when fitted, absorbs the air bubbles mixed between the members at room temperature, so that a product free from air bubbles can finally be obtained without any special treatment. In addition, the terms, any special treatment, refer to such treatment as expelling air bubbles by moving a roll while a pressure is applied from an end portion of the surface of the transparent touch panel 1. Such a special treatment cannot be applied in the case of a transparent touch panel 1 using the glass substrate 11 having optical isotropy, in which case the aforementioned air bubble absorbing effect at room temperature is quite useful.

Next, the method for fabricating the touch-input type liquid crystal display device is described in detail below.

(Upper Optical Phase Difference Film 4 of Touch Panel 1)

The upper optical phase difference film 4 can be given a specified phase difference by uniaxial-orienting an

un-drawn film material. In this embodiment, a rolled film material having a phase difference of 1/4 wavelength in visible light of about 550 nm, which is an example of the wavelength of the largest luminosity factor, by controlling a refractive index in an x-direction, which is the optical axis direction of the film material, a refractive index in a y-direction perpendicular to the x-direction, and a refractive index in a thickness direction of the film material, which is a z-direction perpendicular to the x-direction and the y-direction, and the resultant film material is used for the upper optical phase difference film 4. In addition, when the lower optical phase difference film 6 is given phase difference, the case is the same as in the upper optical phase difference film 4.

(Movable Electrode Portion 3 of Touch Panel 1)

A transparent conductive film forming part of the movable electrode portion 3 is formed on the rolled film material for use of the upper optical phase difference film 4. Processing of this film formation may be performed via sputtering, evaporation, or a CVD process. Before the formation of the transparent conductive film, high temperature treatment needs to be carried out as much as possible in order to remove the residual solvents in the film material. This is because the residual solvents, if present, would make it impossible to form a stable transparent conductive film.

Whereas the transparent conductive film is deposited after the removal of residual solvents, it is necessary to form the film under a temperature of 150°C or more for stabler formation and higher strength of the transparent conductive film. Accordingly, a film material having a thermal deformation temperature of less than 150°C would yield such deteriorations as deformation and distortion with 150°C or more heat, so that the 1/4 wavelength phase difference could not be retained. Also, heat treatment of less than 150°C would result in insufficient removal of the residual solvents, so that a stable, high-strength transparent conductive film could not be obtained. Therefore, since 150°C or more heat treatment is done for the removal of residual solvents in the film material, the film material for forming the transparent conductive film must be a film material having a thermal deformation temperature of 150°C or more.

The film material with a transparent conductive film for use of the upper optical phase difference film 4 made in this way is generally roll-shaped. Therefore, the film material is cut into specified size for circuit formation so as to be formed into sheet-like film material. It is noted that one film material sheet, in some cases, corresponds to one transparent touch panel 1, but without being limited to this, corresponds to any arbitrary number

of transparent touch panels 1 in other cases.

The cut film material sheet is subjected to a heating process, as required, ~~with a view~~ to ~~reducing~~ reduce any dimensional errors in circuit formation. The heating process is desirably done at a temperature of not less than 100°C and less than 130°C for about 1 hour. Thereafter, the circuit formation of leads and the like which are parts of the rest of the movable electrode portion 3 is carried out. The process for the circuit formation may be done by screen printing, offset printing, roll coater, dispenser, or the like. As the ink used for the circuit formation, ink in which metal microparticles having electrical conductivity have been dispersed in a binder made of thermosetting resin is used, and a solvent is added thereto for better printability so that the viscosity is adjusted. As the metal microparticles used for the conductive ink, silver, nickel, copper, gold, or the like is used. High temperature drying process is performed for the curing of the binder and the removal of solvents. The drying process is done at a temperature of not less than 100°C and less than 150°C for 30 - 60 minutes. Drying conditions are adjusted according to the ink used. Needless to say, a film material whose phase difference of 1/4 wavelength is not changed by the heat treatment during the circuit formation is previously selected.

given after the circuit formation in obtaining one film material sheet which is in the state of being set to the transparent touch panel 1 as described later).

Further, during the circuit formation, it is also necessary to keep the transparent conductive film and the leads or the like from unnecessary contact (i.e., unnecessary overlaps). Normally, before the circuit formation, the transparent conductive film is preparatorily patterned into a specified configuration. The patterning process may be a print resist process, or photolithography process, or directly pattern printing of the transparent conductive film.

(Stationary Electrode Portion 5 of Touch Panel 1)

As to the formation of the stationary electrode portion 5, circuit formation is carried out by the generally same processes as in the movable electrode portion 3. In the case where the optically isotropic film 12 or the glass substrate 11 having optical isotropy is located between the lower optical phase difference film 6 and the stationary electrode portion 5, the optically isotropic film 12 or the glass substrate 11 having optical isotropy, which is the target on which the stationary electrode portion 5 is to be directly formed, has no optical axis, so that these members do not need to be angled for the cutting and circuit formation processes. In the case where the stationary

movable electrode portion side and the stationary electrode portion side, in order to avoid insulation failures due to contact of a lead and an electrode between the upper and lower members, and to prevent metal oxidation of circuits. Process for forming the insulating layer may be done by print resist process, screen printing, offset printing, roll coater, dispenser, or the like, as in the circuit formation. Material used therefor is an insulative thermosetting resin or the like.

Also, in order to ensure the insulation between the transparent conductive film of the movable electrode portion 3 and the transparent conductive film of the stationary electrode portion 5 in the touch panel 1, and to enable smoother ON/OFF switching of conduction at operations of pressing or releasing the top surface of the touch panel 1 by pen or finger or the like, a multiplicity of spacers 10 are formed between the transparent conductive film of the movable electrode portion 3 and the transparent conductive film of the stationary electrode portion 5. The surface on which the spacers 10 are formed is given by an electrode surface of the transparent conductive film on at least either one of the stationary electrode portion side and the movable electrode portion side. Process for forming the spacers 10 may be screen printing, offset printing, dispenser process, or the like, by which the spacers 10 of

any arbitrary configuration are formed directly. Also usable are a photolithography process, print resist process, or the like, by which an overall-formed coating is patterned into the configuration of spacers. The spacers, although not limited in configuration particularly, are desirably of the same configuration and arrayed at fixed intervals so as to eliminate any input-disabled portions and to enable uniform inputs. When the spacers are formed in a dot-like shape, the spacers are desirably made small in diameter and low in height. As an example, an arrangement pattern in which spacers having a diameter of 30 - 100 μm and a height of 1 - 15 μm with a spacer pitch of 0.1 - 10 mm fall upon intersecting points of a plurality of lines crossing one another longitudinally and laterally can be obtained by rotating the pattern to 0 - 90° with respect to one side line of the touch panel 1.

(Cutting of One Electrode Sheet)

The movable-side sheet (upper optical phase difference film 4), on which the movable electrode portion 3 has been directly formed, and the stationary-side sheet (optically isotropic film 12, glass substrate 11 having optical isotropy, or lower optical phase difference film 6), on which the stationary electrode portion 5 has been directly formed, with circuits formed on these sheets, are further cut into specified size, in the case of the

Fig. 15 is a sectional view showing a touch-input type liquid crystal display device (transmission type TN) according to a modification of the fourth embodiment.

Fig. 16 is a sectional view showing a touch-input type liquid crystal display device (reflection type STN) according to a modification of the sixth embodiment.

In the figures, reference numeral 22 denotes a transparent film, 23 denotes a low reflection process layer, 24 denotes an antifouling process layer, and 25 denotes a hard coat process layer.

As the base material for directly forming the stationary electrode portion 5 thereon, the lower optical phase difference film 6 (the fourth embodiment, see Fig. 11), or the glass substrate 11 having optical isotropy (the fifth embodiment, see Fig. 12), or the optically isotropic film 12 (the sixth embodiment, see Fig. 13) is used. These base materials are also processed at high temperatures during the formation of the stationary electrode portion 5 and the circuit formation, as in the case of the upper optical phase difference film 4.

Also, if pressing stability and durability equivalent to those of the glass substrate 11 having optical isotropy are preferred to the thinness in the fourth embodiment, a transparent resin plate 16 having optical isotropy may appropriately be disposed between the